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(54) Method for Controlling the Properties of White Liquor

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The present invention relates to a process for con-
trolling the properties of white liquor used by the prepa-
ration of boiling liquor for use in the sulphate process,
the electric conductivity of the liquor being measured by
5 said process after the causticization.

By the so-called kraft process or sulphate process
pulp is prepared by digesting chips of wood in a strongly
alkaline liquor mainly containing NaOH and Na_2S. During the
pulping, the content of NaOH of the liquor is consumed, said
10 content being relatively high at the beginning, whereas its
content of Na_2S remains substantially unchanged.

The spent pulping liquor is called black liquor and con-
tains, inter alia, the dissolved lignin in addition to the re-
sidue chemicals. The black liquor is concentrated and subse-
15 quently burnt in a steam boiler, whereby its content of energy
is utilized. In the bottom of the boiler, the combustion pro-
ducts are collected in the form of a melt mainly consisting of
Na_2S and Na_2CO_3.

The melt is introduced into a tank with water (thin
20 liquor), wherein it is dissolved. The resulting liquor is
called green liquor. The green liquor always contains a small
amount of NaOH which may vary a great deal. The green liquor
is characterized by having a high content of Na_2CO_3 and a
small amount of NaOH. In order to re-form the boiling liquor
25 burnt lime is added to the green liquor in a slaker, in which
the following reactions take place:

Slaking : $CaO + H_2O \rightleftharpoons Ca(OH)_2$ 1)

Causticization: $Ca(OH)_2 + Na_2CO_3 \rightleftharpoons 2NaOH + CaCO_3\downarrow$ 2)

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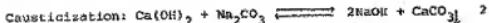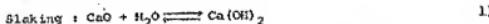
The reactions proceed in parallel towards a state of
equilibrium and are more or less displaced to the right.
The liquor formed by the causticization is called white
liqour.

5   The content of Na_2S of the green liquor does not take
part in the process, but is retrieved in the white liquor.
When the amount of water consumed by the reaction 1) is
ignored (about 2%), the content of Na_2S of the white liquor is
equal to the content of Na_2S of the green liquor.

10 In order   to permit a completion of the processes, the
liquor is transferred from the slaker to the first of a row of
causticizers with stirring. The contents of the first cau-
sticization vessel or causticizer are transferred into the
next vessel and so on until an overflow is established by
15 the causticizers being positioned in gradually lower heights.
. The number of causticizers may vary.

Upon termination of the reaction, the causticized
liquor (white liquor) is separated from the calcareous silt.
Subsequently, the white liquor is used, optionally after
20 additional clarifying, for the preparation of a new pulping
liquor. The white liquor and consequently the pulping liquor
always contain a small amount of unreacted Na_2CO_3. The white
liquor is characterized by containing a high amount of NaOH
and a small amount of Na_2CO_3. The calcareous silt is flushed
25 for liquor residues, dehydrated, and burnt in a rotary kiln
whereby the calcium oxide (xxxt lime) necessary for the cau-
sticization is re-formed. The wash water is called thin liquor

and is utilized in the dissolving tank for the melt formed
from the black liquor, whereby the content of liquor resi-
dues of the thin liquor is reused.

As it will appear, the chemicals circulate in two
5 circuits, viz. one for the sodium (the digesting process
– the evaprotation – the combustion – the dissolving – the
separation from the white liquor – the washing out – the
dehydration – the burning). The unavoidable loss of chemi-
cals is as far as the sodium is concerned replaced by addi-
10 tion of Na_2SO_4 to the concentrated black liquor. At the
combustion, the major part is reduced to Na_2S, which results
in the name the sulphate process. A small amount of NaOH may
furthermore be added to the white liquor. As far as the cal-
cium is concerned, burnt lime CaO may be added at the outlet
15 of the rotary kiln, or lime $CaCO_3$ may be added at the inlet
of the rotary kiln.

The white liquor and the green liquor may be characte-
rised by some quantitites, the defintion of which is recom-
mended to be used by central laboratories of which for wood
20 or paper pulp in Scandinavia, and which for instance are
mentioned in SCAN-N 2:63, whereby the statement of the various
chemical substances is to be understood as the concentration
of the compound in question, calculated as g of NaOH/l:

Active alkali AA = NaOH + Na_2S

25 Efficient alkali EA = NaOH + 0.5 Na_2S

Total alkali = all alkali salts.

Total titratable alkali TTA = NaOH + Na_2S + Na_2CO_3

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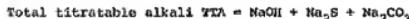
The degree of causticization (in white liquor)

$$C = \frac{NaOH}{NaOH + Na_2CO_3} \times 100\%$$

The sulphidity (in white liquor)

$$S = \frac{Na_2S}{NaOH + Na_2S} \times 100\%$$

5   The degree of reduction (in green liquor)

$$R = \frac{Na_2S}{Na_2SO_4 + Na_2S} \times 100\%$$

Furthermore the following can be mentioned:

The carbonate conversion: $Na_2CO_{3Gr} - Na_2CO_{3Hv}$ g/l

The degree of the carbonate conversion:

10    $$\frac{Na_2CO_{3Gr} - Na_2CO_{3Hv}}{Na_2CO_{3Gr}} \times 100\%$$

The control of the causticization process may choose the calcium cycle, the sodium cycle or both the calcium cycle and the sodium cycle as starting point.

As far as the sodium cycle is concerned, the diffi-
15 cult steps in the process are centred about the combustion of the concentrated black liquor and the causticization process. By the causticization particularly the control of the addition of burnt lime is difficult. This is partly due to the great time lag between the addition of quicklime and
20 the filtration (2-3 hours) of the finished liquor, partly

due to the variability of the burnt lime both with re-
spect to its reactivity (the slaking velocity) and with
respect to its content of active lime. However, the dif-
ficulty in controlling the addition of burnt lime espe-
5 cially depends on the fact that it has not previously
been possible continuously to measure or determine pro-
cess relevant parameters to be used for the required
control.

Previously, the causticization process was often
10 controlled by means of manual regulation of the feeding
of burnt lime on the basis of laboratory analyses of the
white liquor immediately after the slaker and optionally
of the green liquor, whereby it was tried to maintain the
degree of causticization (in the white liquor) at a prede-
15 termined value. This procedure is encumbered with the draw-
back that it is necessary to wait so long for the result of
the analysis that in general it is too late to establish the
necessary restoration of the causticization process. At-
tempts to restore the causticization process may easily in-
20 volve for instance undue calcareous concretion causing a
poorer filtrability and a too high content of calcium in
the white liquor whereby filters, pipes, pumps, boilers etc.
are calcified, cf. K. Kinzner "Untersuchungen zur Causti-
zierung von Grünlaugen", in Proceedings of the Symposium
25 in Recovery of Pulping Chemicals, Helsingfors 1968, page
279. By keeping the specific gravity and consequently the
TTA-value of the green liquor constant, it is possible to in-

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fluence the causticization process positively concerning
keeping of the degree of causticization. However, it is
not possible to take into account the considerable vari-
ation of the quality of the lime by keeping the speci-
5 fic gravity of the green liquor. In addition, the compo-
sition of the green liquor may vary considerably irre-
spective of the fact that the specific gravity and conse-
quently the TTA-value are kept constant. The content of
NaOH of the green liquor may for instance vary considerab-
10 ly depending on the amount of water which it is necessary
to add to the dissolving tank in addition to the thin
liquor in order to dissolve the melt resulting from burning
of the concentrated black liquor.

It is known to control the causticization process by
15 means of an automatic titrator for the determination of
the content of Na_2CO_3 in the green liquor and the white
liquor, two temperature measurings being simultaneously
performed, viz. a temperature measuring of the green
liquor immediately before the slaker and a temperature
20 measuring of the contents of the slaker. The slaking (pro-
cess 1) involves generation of heat, whereas the caustici-
zation (process 2) involves no significant heat content
change. The rise in temperature of 10-15°C renders it
possible to calculate the amount of calcium hydroxide
25 available for the causticization. This calculation renders
it possible to control the addition of burnt lime said
control being performed in preparation for a constant

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degree of causticization. An automatic titrator is, how-
ever, expensive and must be kept up with analysis reagents,
cleaned, and altogether controlled with respect to its
function, and it uses time for performing an analysis. The
5 measurings achieved are therefore delayed relative to the
moment the necessary control signals should have been given.
Consequently, these measurings and the registration thereof
cannot be considered on-line. The rise in the temperature
measured is relatively modest, and in order to achieve an
10 accurate figure of the amount of calcium hydroxide avail-
able for the causticization, the temperatures must be mea-
sured individually with great accuracy.

By another known measuring method, the conductivity of
the white liquor measured after the slaker is used as a mea-
15 surement of the degree of causticization, and this measure-
ment is made the basis of the control of the amount of added
burnt lime. However, the electric conductivity of a solution
depends on all the electrolytes present in the elecrolytic
solution in question, on their concentration, and on the
20 temperature, since in practice it is always necessary to
temperature compensate a conductivity measuring to some
reference temperature. The conductivity of the white liquor
depends not only on the composition of the liquor concerning
NaOH or Na_2CO_3 (the degree of causticization), but also on
25 the content of Na_2S, and the concentration is of particular
importance. Therefore a measuring of the conductivity solely

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of the white liquor does not permit a good determination of a parameter, on which it is possible to base a control of the degree of causticization.

5   As it is known, an aqueous solution of NaOH possesses a much higher conductivity than an aqueous solution of Na_2CO_3 having the same concentration. An aqeous solution of Na_2S having the corresponding concentration possesses a conductivity between the conductivity measured for the NaOH and the Na_2CO_3 solution, respectively.

10   Furthermore the solution having the highest amount of NaOH among the aqeous solutions of mixtures of electrolytes containing NaOH, Na_2S, and Na_2CO_3 possesses the highest conductivity provided the content of Na_2S is constant, the sum of the amounts of substance of

15 said solutions being equal, e.g. calculated as g of NaOH/l or as g of Na_2O/l.

    Concerning a green liquor and the white liquor derived therefrom by causticization, the sum of the amounts of electrolytes, calculated as g of NaOH/l, is equal in the

20 green liquor and in the white liquor, the content of Na_2S not being influenced by the causticization process. Since the white liquor contains more NaOH than the green liquor from which it is derived, it also possesses a higher conductivity than the green liquor, and this recognition is

25 the basis of the invention.

    The process according to the invention is characterized by measuring the electric conductivity of the green liquor before the causticization in addition to the measuring of the conductivity of the white liquor.

Thus, by measuring the conductivity of the green liquor both before the slaker and gradually as it passes through the slaker, it is possible to achieve a unique picture of the causticization process. The second

5 conductivity measuring is in practice performed either within the slaker or immediately thereafter, in which connection it should be noted that an efficient stirring is maintained within the slaker.

The conductivity of the white liquor immediately after

10 the slaker is about half as much as the conductivity of the green liquor. Tests have lead to the recognition that the amount of this increase is proportional to the instant degree of the reaction of Na_2CO_3 into NaOH, and that the amount of the increase is independent of the content of

15 Na_2S and depends only to a minor degree on the total content of chemicals (TTA) of the green liquor. The conversion of Na_2CO_3 into NaOH from one point to another in the process is therefore measureable by a difference measuring of the conductivity by means of two conductivity meters. The high re-

20 lative increase in the conductivity ensures a very accurate determination of the carbonate conversion.

It turned out surprisingly, that it is possible to tabulate a formula expression in the form of a fraction, the conductiviy of the green liquor and of the white liquor for-

25 ming part of the numerator, and the TTA-value forming part of an expression of the second degree in the denominator:

$$\frac{\kappa_{Hv} - \kappa_{Gr}}{f_1(TTA)} \ ,$$

where $f_1(TTA) = 4.694 \cdot 10^{-5} \cdot TTA^2 - 2.652 \cdot 10^{-2} \cdot TTA + 7.335 \ (\frac{mS/cm}{g/l})$

The TTA of the green liquor forms part of the resul-
ting expression, but since the variation therein have a re-
latively minor influence on the accuracy, a TTA-value ob-
tained by measuring an arbitrary parameter is satisfactory,
said parameter correlating with the TTA-value to a suffi-
ciently high degree.

The specific gravity turned out for instance to meet
said condition, and a preferred embodiment of the process
according to the invention is therefore characterized by
determining the TTA-value (total titratable alkaline), pre-
ferably be measuring the specific gravity of the green
liquor or the absorption of a gamma radiation by the green
liquor.

As in the following formulae, the formula of the car-
bonate conversion is a formula of general application at
other temperatures than the temperature actually present
provided the conductivities κ_{Gr} and κ_{Hv} measured are tempe-
rature compensated to an appropriate reference temperature
$\underline{t}^oC$. The preferred reference temperature is 90^oC, and the
formulae thus apply by the use of a reference temperature
within a predetermined range about 90^oC.

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According to a further embodiment of the invention, the
quantities characteristic for the production plant, pre-
ferably $\underline{x}$ and $\underline{y}$, are determined by means of chemical
analysis of the green liquor and the white liquor, whereby
5 $\underline{x}$ is the ratio of the content of Na_2S to the content of
Na_2CO_3 in the green liquor, both parts being calculated as
g of NaOH/l, and whereby $\underline{y}$ is the ratio of the content of
Na_2S in the white liquor, calculated as g of NaOH/l, to TTA.

Instead of the above ratios $\underline{x}$ and $\underline{y}$, it is possible
10 to use arbitrary ratios of the content of NaOH, Na_2S,
Na_2CO_3 and TTA of the green liquor and of the white liquor,
respectively, depending on what has shown to be most appro-
priate based on measurements of working on the plant in
question.

15   A formula expression can be set up, in which the con-
ductivity of the green liquor forms part, whereby the con-
tent thereof of Na_2CO_3 can be calculated by inserting the
numerical value from a measuring of the conductivity and the
TTA-value determined by measuring the specific gravity:

20 $$Na_2CO_{3,Gr} = \frac{f_2(TTA) - \mu_G}{f_1(TTA) + x \cdot f_3(TTA)}$$

where $f_2(TTA) = -1.158 \cdot 10^{-2} \cdot TTA^2 + 6.939 \cdot TTA + 192.6$ (mS/cm)

$f_3(TTA) = 5.307 \cdot 10^{-5} \cdot TTA^2 - 2.030 \cdot 10^{-2} \cdot TTA + 3.512$ ($\frac{mS/cm}{g/l}$)

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Tests have shown that the ratio of the content of Na_2S to Na_2S to Na_2CO_3 of the green liquor with a sufficiently good approximation can be equalized with a constant value $\underline{x}$ characteristic of the causticizing plant

5 in question under the prevailing operational conditions so that the numerical value thereof can be inserted in the formula expression.

Similarly a formula expression can be set up, in which the conductivity of the white liquor forms part,

10 whereby the content hereof of NaOH can be calculated by inserting the numerical value from a conductivity measuring as well as the TTA-value obtained by measuring the specific gravity:

$$NaOH = \frac{\mu_{RV} - y \cdot f_4(TTA) - f_5(TTA)}{f_1(TTA)}$$

15 $f_4(TTA) = -6.129 \cdot 10^{-6} \cdot TTA^3 \cdot 6.226 \cdot 10^{-3} \cdot TTA^2 +$
    $3.823 \cdot TTA$ (mS/cm)
  $f_5(TTA) = 2.754 \cdot 10^{-5} \cdot TTA^3 - 1.618 \cdot 10^{-2} \cdot TTA^2 +$
    $3.877 \cdot TTA$ (mS/cm)

Tests have shown that the ratio of the content of

20 Na_2S of the white liquor to the TTA-value with sufficiently good approximation can be equalized with a constant value $\underline{y}$ characteristic of the causticizing plant in question under the prevailing operational conditions so that the numerical value thereof can be inserted in the formal expression.

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These measurings render it possible to calculate the
carbonate conversion, the content of Na_2CO_3 of the green
liquor, the content of NaOH of the white liquor, the degree
of carbonate conversion, the causticizing degree of the
5   white liquor, the sulphidity of the white liquor, the
content of active alkali of the white liquor, and/or the
content of efficient alkali of the white liquor, and the
properties of the white liquor are subsequently controll-
able on the basis thereof.

10   Commercially accessible, industrial conductivity
meters (e.g. for measuring in accordance with the 4-elec-
trode principle) are today available for the measurings of
the electric conductivity. These conductivity meters mea-
sure very accurately also in media in which a heavy calci-
15 fication of the measuring cell must be anticipated. Such
conductivity meters are sturdy and accurately measuring
instruments which have gained a footing whithin the indu-
stry, and which do not require particular tending or
keeping up in the form of providing with
20 reagents as for instance in case of a titrator. Such con-
ductivity meters have very short response times and trans-
mit a continuous signal which can be used advantageously
for automatic control.

By the process according to the invention, the mea-
25 suring signals can be used for the control of the proper-
ties of the white liquor by regulating the amount of burnt
lime introduced into the slaker, by regulating the amount of

green liquor transferred into the slaker, and/or by
regulating the TTA-value of the green liquor. Conse-
quently the properties of the white liquor are controlled
at the same time as the amount of white liquor can be
5 changed in response to the requirements.

    For this purpose a data processor is preferably
used for on-line registration of the measuring values,
for the calculation of the change required of the amount
of burnt lime added to the slaker per time unit, and/or
10 for the calculation of the change in question of the
amount of green liquor fed to the slaker per time unit,
and/or for the calculation of the required change of the
TTA-value of the green liquor concerning the control of
said added amounts or of the TTA-value.

15   When the process does not pass off in the steady
state, its dynamics must be considered, the values of
TTA and κ_{Gr} then to be inserted in the formulae must be
the values registered on that point in the process where
κ_{Hv} is measured if no causticization took place (no addi-
20 tion of CaO). According to a preferred embodiment of the
invention, a small partial flow of the green liquor is re-
moved and transferred to a measuring vessel with stirring
and similar to the slaker in such a manner that the volume
ratio of the slaker to the measuring vessel is equal to the
25 ratio of the respective amounts of green liquor fed thereto,
whereby conductivity measuring and/or a TTA-determination
are performed on a corresponding place in the measuring

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vessel as in the slaker. In this manner the conductivity
and the TTA-value of the green liquor measured in the
measuring vessel adapted thereto are immediately usable
in the formulae as the values aimed at. Nothing, however,
5 prevents said value from being measured directly in the
green liquor fed to the slaker, as well as nothing pre-
vents the time lag and "the admixing" from being subse-
quently simulated by means of calculatable methods to
obtain the values aimed at of the conductivity and the
10 TTA in green liquor. Such a simulation of the time lag
and the admixing is preferred since it is easily adjust-
able to the particular mode of operation of various indu-
strial installations.

In the general case the calculation of the carbonate
15 conversion . thus involves the use of a model of the
process whereby the time lag and the admixing of the green
liquor entering the slaker are considered. This calculation
is, of course, carried out by means of the computer system
used for on-line registration of the measurements.
20 Since the causticization process is not fully comple-
ted within the slaker, only 70-80% of the reaction taking
place within the slaker, and the remaining 20-30% of the
reaction taking place in the causticizers, it is by mea-
suring in three or several places possible to provide a
25 still better picture of the passing off of the process.

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Especially by measuring the conductivity of the white liquor after separation of the calcareous silt, it is possible to obtain information on the state of the finished liquor for the following preparation of the pulp-

5 ing liquor.

By the process according to the invention it is therefore advantageous to perform the measuring of the conductivity after termination of the causticization within the slaker or the discharge part thereof (the

10 classifier),   and/or within one or more of the follow- ing causticizers or the outlet conduits thereof and/or within the clarified white liquor,

In this manner the control system used can be adapted to the use of so-called tuning, whereby measuring

15 of the conductivity of the white liquor on two places within the causticizers is compared with the measurement of the conductivity and the TTA-value of the green liquor. The relevant process parameters on the two measuring places are calculated by using dynamic models corresponding to the

20 two places for measuring the conductivity of the white liquor. These white liquor parameters are subsequently applicable for providing a better basis of determination for the operator at manual control or for providing a better basis of determination for the change of the set

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-value at a PID-regulation (proportional integral differ-
ential regulation) or for up-dating the control parameters in
a control system in order to optimize the properties of
the finished white liquor.

The invention will be described below with
reference to the accompanying drawing and an example.

The drawing is a diagrammatic view of a
causticizing plant used in the sulphate process.

Green liquor 1 is formed by dissolving the melt
from the combustion of black liquor after concentration, in
water and thin liquor, is transferred into a slaker 2 in
which slaking and causticization are carried out during
addition of burnt lime. The resulting precipitate deposited
in the classifier is carried out of the slaker by means of
a worm conveyor, whereas the content of the slaker of milk
of lime passes to causticizers 3, 4 and 5 through overruns.
From the last causticizer, the white liquor is carried to-
gether with calcareous silt to a separating and washing
filter 6. From this filter the filtrated white liquor con-
tinues to a storage tank (not shown) via line 7. The washed
calcareous silt is transferred into a vessel 8 and further to
a dehydration filter 9. Subsequently, the calcareous silt is
carried to a rotary kiln for burning, whereby supplementing
lime (not burnt) can be added immediately before the rotary
kiln 10 at 14. The burnt lime which can be supplemented with
burnt lime 13 is transferred to a lime silo 11, a conveyor
mechanism 12 for the lime being situated below said silo.

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This conveyor mechanism 12 carries the burnt lime into the slaker 2.

The process variables mentioned in the following example are for instance desired to be determined on two
5 places in the causticizing plant, place A and place B referred to as 15 and 16, respectively. A flowmeter 17, a densimeter 18 (measuring the TTA-value), a conductivity meter 19 (green liquor), a conductivity meter 20 (white liquor immediately after the slaker), and a conductivity meter 21
10 (the completed white liquor) are used for this purpose.

The delayed values of TTA and the conductivity of the green liquor are calculated in a calculation unit 22, and the signals in question are transferred to calculation unit 23 and 25 also supplied with the signals from the con-
15 ductivity meters 20 and 21, respectively. On the places A and B, the process variables are calculated in the calculation units 23 and 25, and based on these variables control signals 24 and 26 are generated and are transmitted for the desired control of added amount of burnt lime per time unit, added
20 amount fo green liquor per time unit or the TTA-value in the green liquor.

Example

In a paper pulp producing plant, the following measurements were carried out in the causticizing plant after
25 a long period of steady state, whereby comparison with laboratory analyses can be carried out:

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$$\kappa Gr, 90^{\circ}C = 498.0 \text{ mS/cm}$$
$$\kappa Hv, 90^{\circ}C = 723.3 \text{ mS/cm}$$
$$Vf_{90^{\circ}C} = 1.135 \text{ kg/l} - TTA = 142.2 \text{ g/l}$$

The quantities x and y characteristic of the process
are found from the average value of 9 weeks' laboratory
analyses as follows:

$$x = \frac{Na_2S_{Gr}}{Na_2CO_{3Gr}} = 0.2772$$

$$y = \frac{Na_2S_{Hv}}{TTA} = 0.1677$$

In the following, all the concentrations of substance
have been stated as g of NaOH/l. The connection between
specific gravity $(90^{\circ}C)$ and TTA was found to be:

$$TTA = Vf_{90} \cdot 962.2 - 949.9 \text{ (g/l)}$$
$$R = 92\%$$

whereby the specific gravity at $90^{\circ}C$ and the figures 962.2
and 949.9 are obtained by means of a row of measurings of
the specific gravity and corresponding chemical analyses
for the determination of the TTA-value based on linear
regression, and R is the correlation factor.

1) <u>Carbonate Conversion</u>

carbonate conversion $= \dfrac{\kappa_{Hv} - \kappa_{Gr}}{f_1(TTA)}$

where $f_1(TTA) = 4.694 \cdot 10^{-5} \cdot TTA^2 - 2.652 \cdot 10^{-2} \cdot TTA + 7.335 \; (\frac{mS/cm}{g/l})$

<u>Illustrated with figures:</u>

5   carbonate conversion $= \dfrac{723.3 - 498.0}{4.513} = \underline{49.9 \; g/l}$

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2) Na_2CO_3 in green liquor

$Na_2CO_{3,Gr} = \dfrac{f_2(TTA) - \mu_G}{f_1(TTA) + x \cdot f_3(TTA)}$

where $f_2(TTA) = -1.158 \cdot 10^{-2} \cdot TTA^2 + 6.939 \cdot TTA + 192.6 \; (mS/cm)$

$f_3(TTA) = 5.307 \cdot 10^{-5} \cdot TTA^2 - 2.030 \cdot 10^{-2} \cdot TTA + 3.512 \; (\frac{mS/cm}{g/l})$

10

<u>Illustrated with figures:</u>

$Na_2CO_{3,Gr} = \dfrac{945.2 - 498.0}{4.513 + 0.2772 \cdot 1.6985} = \underline{89.7 \; g/l}$

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3) NaOH in white liquor

$$NaOH = \frac{\mu_{HV} - y - f_4(TTA) - f_5(TTA)}{f_1(TTA)}$$

$$f_4(TTA) = -6.129 \cdot 10^{-6} \cdot TTA^3 - 6.226 \cdot 10^{-3} \cdot TTA^2 + 3.823 \cdot TTA \ (mS/cm)$$

$$f_5(TTA) = 2.754 \cdot 10^{-5} \cdot TTA^3 - 1.618 \cdot 10^{-2} \cdot TTA^2 + 3.877 \cdot TTA \ (mS/cm)$$

Illustrated with figures:

$$NaOH = \frac{723.3 - 0.1677 \cdot 400.1 - 303.3}{4.513} = 78.2 \ g/l$$

4) Degree of Carbonate Conversion

$$\frac{Carbonate \ conversion}{Carbonate \ in \ green \ liquor} \cdot 100\% = \frac{49.9}{9.7} \cdot 100\% = 55.7\%$$

5) Causticizing degree of white liquor

$$C\% = \frac{NaOH_{HV}}{Na_2CO_{3,Gr} - carbonate \ conversion}$$

$$C\% = \frac{78.2}{89.7 - 49.9 + 78.2} \cdot 100\% = 66.3\%$$

6) The sulphidity of white liquor

$$S\% = \frac{Na_2S_{HV}}{NaOH_{HV} + Na_2S_{HV}} \cdot 100\%$$

$$Na_2S_{HV} = TTA - NaOH_{HV} - Na_2CO_{3HV},$$

$$Na_2CO_{3HV} = Na_2CO_{3,Gr} - \text{carbonate conversion}$$

providing

$$S\% = \frac{TTA - NaOH_{HV} - Na_2CO_{3,Gr} + \text{carbonate conversion}}{TTA - Na_2CO_{3,Gr} + \text{carbonate conversion}}$$

Illustrated with figures:

$$S\% = \frac{142.2 - 78.2 - 89.7 + 49.9}{142.2 - 89.7 + 49.9} \cdot 100\% = \underline{23.6\%}$$

7) Active alkali in white liquor

$$AA = NaOH_{HV} + Na_2S_{HV}$$

$$= TTA - Na_2CO_{3\ HV} = TTA + Na_2CO_{3,Gr} - \text{carbonate conversion}$$

Illustrated with figures:

$$AA = 142.2 + 49.9 - 89.7 = \underline{102.4\ g/l}$$

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8) Efficient alkali in white liquor

$EA = NaOH_{HV} + 1/2\ Na_2S_{HV}$

$= NaOH_{HV} + 1/2\ (TTA - NaOH_{HV} - Na_2CO_{3HV})$

$= 1/2\ (NaOH_{HV} + TTA - NaCO_{3,Gr} + $ carbonate conversion
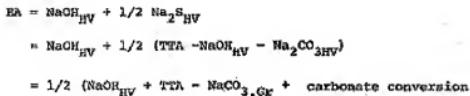
Illustrated with figures:

5    $EA = 1/2\ (78.2 + 142.2 - 89.7 + 49.9) = \underline{90.3\ g/l}$

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A process for controlling the causticization
process in the causticization step of the sulphate process
and, consequently, the composition of the white liquor
used by the preparation of boiling liquor in the sulphate
process, wherein the electrical conductivity of the white
liquor is measured after termination of the causticization
step; the improvement in said process comprising:
additionally measuring the electrical conductivity of the
green liquor before the causticization step, and using the
conductivity measurements to calculate the characteristic
numeric values of the composition of the white liquor,
wherein said values are used to control the causticization
process.

2. A process as claimed in claim 1, wherein the
improvement additionally comprises: determining the total
titratable alkali value of the green liquor.

3. A process as claimed in claim 2, wherein
the total titratable alkali value is obtained by measuring
the specific gravity of the green liquor or the gamma
radiation absorption of the green liquor.

4. A process as claimed in claim 2, wherein
the improvement additionally comprises: determining
quantities characteristic for a production plant used in
said process.

5. A process as claimed in claim 3, wherein
the improvement additionally comprises: determining
quantities characteristic for a production plant used in

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said process.

6. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l.

7. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations.

8. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH con-

centration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations.

9. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by the amount of burnt lime introduced into a slaker used in said process.

10. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; and additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the

active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by the amount of burnt lime introduced into a slaker used in said process.

11. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor.

12. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the

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white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor.

13. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements: the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor.

14. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements: the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the

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active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and
by regulating the total titratable alkali value of the green
liquor.

15. A process as claimed in claim 2 or 3,
wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration
of the green liquor, the carbonate conversion and NaOH
concentration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, and by regulating the
total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor
is transferred, with stirring, to a measuring vessel,
similar to a slaker used in said process in such a manner
that the volume ratio of the slaker to the measuring vessel
is equal to the ratio of the respective amounts of green
liquor fed thereto, wherein one or more of a conductivity
measurement, and total titratable alkali value are determined
at a corresponding place in the measuring vessel to the
slaker, were the slaker to be used instead of the measuring
vessel.

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16. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to a slaker used in said process in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel.

17. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

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calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to the slaker in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel.

18. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to a slaker used in said process per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor.

19. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a data processor is used for on-line registration of the measured values for calculating one

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or more of the following: the amount of burnt lime to be added to a slaker used in said process per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor.

20. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor;

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor.

21. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH

concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to a slaker used in said process in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel; and

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor.

22. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement

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comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and $NaOH$ concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to a slaker used in said process in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel; and

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor.

23. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

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calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to the slaker in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel; and

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor.

24. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

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calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: a slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

25. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the

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total titratable alkali value of the green liquor;

      wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: a slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

      26. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

      calculating the following, through measurements:

      the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

      controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor;

      wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

      27. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

      calculating the following, through measurements;

      the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH

concentration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, and by regulating the
total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor
is transferred, with stirring, to a measuring vessel,
similar to a slaker used in said process in such a manner
that the volume ratio of the slaker to the measuring vessel
is equal to the ratio of the respective amounts of green
liquor fed thereto, wherein one or more of a conductivity
measurement, and total titratable alkali value are determined
at a corresponding place in the measuring vessel to the
slaker, were the slaker to be used instead of the measuring
vessel; and

wherein the conductivity measurement after the
termination of the causticization step is effected in one
or more of the following: the slaker, a classifier, a
following causticizer or outlet thereof, of a plant used
for said process, and the clarified white liquor.

28. A process as claimed in claim 4 or 5,
wherein said quantities are x and y obtained by means of
chemical analysis of the green and white liquors,
respectively, wherein x is the concentration ratio of
Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l
and y is the concentration ratio of Na_2S to total titratable
alkali calculated as g NaOH/l; an additional improvement
comprising:

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calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor; .

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to a slaker used in said process in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

29. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the

active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to the slaker in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

30. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

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controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to a slaker used in said process per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

31. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

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controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to a slaker used in said process per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

32. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor;

wherein a data processor is used for on-line

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registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

33. A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to a slaker used in said process in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the

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slaker, were the slaker to be used instead of the measuring vessel;

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

34. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of chemical analysis of the green and white liquors, respectively, wherein x is the concentration ratio of Na_2S to Na_2CO_3 in the green liquor calculated as g NaOH/l and y is the concentration ratio of Na_2S to total titratable alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, and by regulating the

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total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to a slaker used in said process in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel;

wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

35.   A process as claimed in claim 2 or 3, wherein the improvement additionally comprises:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the

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white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and by
regulating the total titratable alkali value of the green
liquor;

wherein a small partial flow of the green liquor
is transferred, with stirring, to a measuring vessel,
similar to the slaker in such a manner that the volume ratio
of the slaker to the measuring vessel is equal to the ratio
of the respective amounts of green liquor fed thereto,
wherein one or more of a conductivity measurement, and
total titratable alkali value are determined at a corres-
ponding place in the measuring vessel to the slaker, were
the slaker to be used instead of the measuring vessel;

wherein a data processor is used for on-line
registration of the measured values for calculating one or
more of the following: the amount of burnt lime to be
added to the slaker per unit time, the amount of green
liquor to be added to the slaker per unit time, and the
total titratable alkali value of the green liquor; and

wherein the conductivity measurement after the
termination of the causticization step is effected in one or
more of the following: the slaker, a classifier, a following
causticizer or outlet thereof, of a plant used for said
process, and the clarified white liquor.

36. A process as claimed in claim 4 or 5,
wherein said quantities are x and y obtained by means of
chemical analysis of the green and white liquors,

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respectively, wherein x is the concentration ratio of Na_2S
to Na_2CO_3 in the green liquor calculated as g NaOH/l and
y is the concentration ratio of Na_2S to total titratable
alkali calculated as g NaOH/l; an additional improvement
comprising:

        calculating the following, through measurements:

        the carbonate conversion and Na_2CO_3 concentration
of the green liquor, the carbonate conversion and NaOH
concentration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

        controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and by
regulating the total titratable alkali value of the green
liquor;

        wherein a small partial flow of the green liquor
is transferred, with stirring, to a measuring vessel,
similar to a slaker used in said process in such a manner
that the volume ratio of the slaker to the measuring vessel
is equal to the ratio of the respective amounts of green
liquor fed thereto, wherein one or more of a conductivity
measurement, and total titratable alkali value are determined
at a corresponding place in the measuring vessel to the
slaker, were the slaker to be used instead of the measuring
vessel.

       37. A process as claimed in claim 4 or 5,
wherein said quantities are x and y obtained by means of
chemical analysis of the green and white liquors,

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respectively, wherein x is the concentration ratio of Na_2S
to Na_2CO_3 in the green liquor calculated as g NaOH/l, and
y is the concentration ratio of Na_2S to total titratable
alkali calculated as g NaOH/l; an additional improvement
comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration
of the green liquor, the carbonate conversion and NaOH
concentration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and
by regulating the total titratable alkali value of the green
liquor;

wherein a data processor is used for on-line
registration of the measured values for calculating one or
more of the following: the amount of burnt lime to be
added to a slaker used in said process per unit time, the
amount of green liquor to be added to the slaker per unit
time, and the total titratable alkali value of the green
liquor.

38. A process as claimed in claim 4 or 5,
wherein said quantities are x and y obtained by means of
chemical analysis of the green and white liquors,
respectively, wherein x is the concentration ratio of Na_2S
to Na_2CO_3 in the green liquor calculated as g NaOH/l and
y is the concentration ratio of Na_2S to total titratable

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alkali calculated as g NaOH/l; an additional improvement
comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration
of the green liquor, the carbonate conversion and NaOH con-
centration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and by
regulating the total titratable alkali value of the green
liquor;

wherein a small partial flow of the green liquor
is transferred, with stirring, to a measuring vessel,
similar to a slaker used in said process in such a manner
that the volume ratio of the slaker to the measuring vessel
is equal to the ratio of the respective amounts of green
liquor fed thereto, wherein one or more of a conductivity
measurement, and total titratable alkali value are determined
at a corresponding place in the measuring vessel to the
slaker, were the slaker to be used instead of the measuring
vessel; and

wherein a data processor is used for on-line
registration of the measured values for calculating one or
more of the following: the amount of burnt lime to be
added to the slaker per unit time, the amount of green liquor
to be added to the slaker per unit time, and the total
titratable alkali value of the green liquor.

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39. A process as claimed in claim 4 or 5,
wherein said quantities are x and y obtained by means of
chemical analysis of the green and white liquors,
respectively, wherein x is the concentration ratio of Na_2S
to Na_2CO_3 in the green liquor calculated as g NaOH/l and
y is the concentration ratio of Na_2S to total titratable
alkali calculated as g NaOH/l; an additional improvement
comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration
of the green liquor, the carbonate conversion and NaOH
concentration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and
by regulating the total titratable alkali value of the green
liquor;

wherein the conductivity measurement after the
termination of the causticization step is effected in one
or more of the following: a slaker, a classifier, a following
causticizer or outlet thereof, of a plant used for said
process, and the clarified white liquor.

40. A process as claimed in claim 4 or 5,
wherein said quantities are x and y obtained by means of
chemical analysis of the green and white liquors, respec-
tively, wherein x is the concentration ratio of Na_2S to
Na_2CO_3 in the green liquor calculated as g NaOH/l and
y is the concentration ratio of Na_2S to total titratable

alkali calculated as g NaOH/l; an additional improvement comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration of the green liquor, the carbonate conversion and NaOH concentration of the white liquor, and one or more of the active alkali and effective alkali concentrations of the white liquor; and

controlling the composition of the white liquor on the basis of such calculations, by the amount of burnt lime introduced into a slaker used in said process, and by regulating the total titratable alkali value of the green liquor;

wherein a small partial flow of the green liquor is transferred, with stirring, to a measuring vessel, similar to a slaker used in said process in such a manner that the volume ratio of the slaker to the measuring vessel is equal to the ratio of the respective amounts of green liquor fed thereto, wherein one or more of a conductivity measurement, and total titratable alkali value are determined at a corresponding place in the measuring vessel to the slaker, were the slaker to be used instead of the measuring vessel;

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

41. A process as claimed in claim 4 or 5, wherein said quantities are x and y obtained by means of

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chemical analysis of the green and white liquors,
respectively, wherein x is the concentration ratio of Na_2S
to Na_2CO_3 in the green liquor calculated as g NaOH/l and
y is the concentration ratio of Na_2S to total titratable
alkali calculated as g NaOH/l; an additional improvement
comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration
of the green liquor, the carbonate conversion and NaOH
concentration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and
by regulating the total titratable alkali value of the green
liquor;

wherein a data processor is used for on-line
registration of the measured values for calculating one or
more of the following: the amount of burnt lime to be
added to a slaker used in said process per unit time, the
amount of green liquor to be added to the slaker per unit
time, and the total titratable alkali value of the green
liquor; and

wherein the conductivity measurement after the
termination of the causticization step is effected in one
or more of the following; the slaker, a classifier, a
following causticizer or outlet thereof, of a plant used for
said process, and the clarified white liquor.

42. A process as claimed in claim 4 or 5,
wherein said quantities are x and y obtained by means of
chemical analysis of the green and white liquors,
respectively, wherein x is the concentration ratio of Na_2S
to Na_2CO_3 in the green liquor calculated as g NaOH/l and
y is the concentration ratio of Na_2S to total titratable
alkali calculated as g NaOH/l; an additional improvement
comprising:

calculating the following, through measurements:

the carbonate conversion and Na_2CO_3 concentration
of the green liquor, the carbonate conversion and NaOH
concentration of the white liquor, and one or more of the
active alkali and effective alkali concentrations of the
white liquor; and

controlling the composition of the white liquor
on the basis of such calculations, by the amount of burnt
lime introduced into a slaker used in said process, and by
regulating the total titratable alkali value of the green
liquor;

wherein a small partial flow of the green liquor
is transferred, with stirring, to a measuring vessel,
similar to a slaker used in said process in such a manner
that the volume ratio of the slaker to the measuring vessel
is equal to the ratio of the respective amounts of green
liquor fed thereto, wherein one or more of a conductivity
measurement, and total titratable alkali value are determined
at a corresponding place in the measuring vessel to the
slaker, were the slaker to be used instead of the measuring
vessel; and

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wherein a data processor is used for on-line registration of the measured values for calculating one or more of the following: the amount of burnt lime to be added to the slaker per unit time, the amount of green liquor to be added to the slaker per unit time, and the total titratable alkali value of the green liquor; and

wherein the conductivity measurement after the termination of the causticization step is effected in one or more of the following: the slaker, a classifier, a following causticizer or outlet thereof, of a plant used for said process, and the clarified white liquor.

43. A process for controlling the causticizing process of green liquor in the sulphate process, which produces an alkaline white liquor for pulping of wood, comprising:

(a) measuring immediately after the causticizing process the value of the electric conductivity of the white liquor formed thereby;

(b) measuring immediately before said causticizing process the value of the conductivity of the green liquor being fed into said process;

(c) numerically correlating the conductivity of said white liquor and said green liquor to obtain the reaction of carbonate value for said causticizing process by means of the equation:

$$\text{Reaction of Carbonate} = \frac{K_{Hv} - K_{Gr}}{f_1(TTA)}$$

wherein $f_1(TTA) = 4.694 \times 10^{-5} \times (TTA)^2 - 2.652 \times 10^{-2}(TTA) + 7.335 \quad (\frac{mS/cm}{q/l})$ wherein K_{Hv} and K_{Gr} are the conductivities of the white and green liquors, respectively, and TTA is the total titratable

alkali of the green liquor; and

(d) adjusting the reaction of carbonate in said causticizing process based on the reaction of carbonate value obtained in step (c).

44. The process of claim 43, further comprising:

(e) measuring the value of the specific gravity of the green liquor to obtain the value of the total titratable alkali of said liquor.

45. The process of claim 43, wherein the value of the total titratable alkali of said green liquor is obtained by measuring the gamma ray absorption of said green liquor.

46. The process of claim 44, further comprising:

(f) chemically determining the value of the concentration of Na_2S and of Na_2CO_3 in said green liquor, to obtain the values x and y, wherein x is the ratio of the value of the concentrations of said Na_2S and said Na_2CO_3 expressed as g NaOH/l and y is the ratio of the value of the concentration of Na_2S in said white liquor and the value of said total alkali of said green liquor expressed as g NaOH/l; and

(g) then using said x and y values in step (d) for adjusting the reaction of carbonate in said causticizing process.

47. The process of claim 44, further comprising:

(f) measuring the value of the specific gravity of said green liquor to obtain the value of the total alkali of said liquor;

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(g) correlating the specific gravity, the electrical conductivity and the total alkali of said white and said green liquors to obtain the value for the content of Na_2CO_3 and NaOH in the green liquor, the degree of reaction of carbonate in the causticizing process and the content of NaOH, the content of active alkali, the content of affective alkali, the degree of causticizing and the sulphidity in the white liquor; and

(h) then using one or more of said values in step (d) for adjusting the raction of carbonate in said causticizing process.

48. The process of claim 43, further comprising:

(e) constantly removing a small part of the green liquor immediately prior to entering a slaker, wherein said causticizing process begins; and

(f) transferring said part to a vessel thereof, whereby a further measurement of the conductivity of said green liquor can be made, the volume ratio of said vessel to said slaker being equal to the volume ratio of the respective parts of green liquor fed thereto.

49. The process of claim 44, further comprising:

(f) on-line transferring said measured value of specific gravity to a data processor to calculate the degree of adjusting of the reaction of carbonate of step (d) per unit time.

50. The process of claim 44, wherein step (d) is carried out by adjusting the amount of quick lime, the value of the total alkali or the amount of the green liquor, or a combination thereof being fed per unit time to a slaker, wherein said causticizing process begins.

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51. The process of claim 44, further comprising:

(f) constantly removing a small part of the green liquor immediately prior to entering a slaker, wherein said causticizing process begins; and

(g) transferring said part to a vessel thereof, whereby a further measurement of one or more of the conductivity and the specific gravity of said green liquor can be made, the volume ratio of said vessel to said slaker being equal to the volume ratio of the respective parts of green liquor fed thereto.

52. The process of claim 43, further comprising:

(e) on-line transferring said measured values obtained in steps (a) and (b) to a data processor to calculate the degree of adjusting of the reaction of carbonate of step (d) per unit time.

53. The process of claim 43, wherein step (d) is carried out by adjusting the amount of quick lime, or the amount of the green liquor, or a combination thereof, being fed per unit time to a slaker, wherein said causticizing process begins.

54. The process of claim 43, wherein the conductivity of said white liquor of step (a) is measured within a slaker, wherein said causticization process begins, within one or more causticizers, whereto the partially causticized white liquor is transferred therefrom at the outlet of one or more of the causticizers, whereby the causticized white liquor is discharged from said causticizers, or a combination thereof.

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55. The process of claim 44, wherein the conductivity of said white liquor of step (a) is measured within a slaker, wherein said causticization process begins, within one or more causticizers, whereto the partially causticized white liquor is transferred therefrom, at the outlet of one or more of the causticizers, whereby the causticized white liquor is discharged from said causticizers, or a combination thereof.

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